Innovations and emerging applications from Hydromet Services in Resilience Development

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South Asia Hydromet Services Forum (SAHF II)
Pathways for Regional Collaboration
20 November, 2019
Talking points

Hydrometeorological hazards include tropical cyclones (also known as typhoons and hurricanes), thunderstorms, hailstorms, tornados, blizzards, heavy snowfall, avalanches, coastal storm surges, floods including flash floods, drought, heatwaves and cold spells.

Sahani et al. 2019 and Amarnath et al. 2017 and 2019
Trends in disaster impact in Asia and the Pacific

Decreasing mortality; increasing economic losses

- Decrease in mortality
- Disaster losses are outpacing the region’s economic growth
- Annual economic losses stand at US$675 billion, or 2.4% of the region's GDP (including drought impact)

Source: UNDRR, ESCAP, EMDAT
Evaluation and comparison of satellite-based rainfall products

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Data Source</th>
<th>Prec (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CHIRPS</td>
<td>65.87</td>
</tr>
<tr>
<td>2</td>
<td>TRMM</td>
<td>109.13</td>
</tr>
<tr>
<td>3</td>
<td>PERSIANN-CDR</td>
<td>44.64</td>
</tr>
<tr>
<td>4</td>
<td>GPM_L3</td>
<td>94.66</td>
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<tr>
<td>5</td>
<td>GSMaP</td>
<td>94.66</td>
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AWS Record 117.4mm (13 August 2018)

- Except PERSIANN and CHIRPS rest of the SRE products are closer to the AWS data with an error by 9 to 19%
- Satellite rainfall products can complete hydromet for flood forecasting
- Combined products reduces uncertainties in extreme weather events
Hydromet optimization tool (v1)

- Guide the process of impactful investments in hydromet and early warning services;
- Digital data solutions can help in optimizing the hydromet operations to strengthen hydrological simulations to manage disaster risks;

https://wrd_iwmi.users.earthengine.app/view/hydromet
Mapping global water-related disaster risk

Overall Risk

Population Exposure

Economic Losses

Floods

Landslides

Drought

Publicly available data sources

Global Risk Data Platform (UNEP)
Socioeconomic Data and Applications Center (SEDAC)
Human Development Report (UNDP)

Highest class (>19): India, Nepal, Cambodia, Vietnam, Laos, Ethiopia, Malawi, Ecuador

Climate Screening products for investing in disaster resilience

• Mapping individual hazards (Flood, Drought, Landslides, Coastal inundation, Cyclone, Forest fires, Earthquake, Extreme rainfall, Heatwaves and Sea level rise);

• Multi-hazard Risk Assessment to support in developing DRM policies and financial investment portfolio for building resilience

Source: IWMI
Multi-hazard Economic Exposure Map

1. Data
This multi-hazard economic exposure map is based on different data sources including four individual hazard maps (flood, storm, earthquake and drought) and the 2015 Gross Domestic Product. The first step involved extraction of GDP values exposed to individual hazards and the second step applied weightage on the economic exposure using historical disaster losses from hazard events in the region year 1993-2017 obtained from EM-DAT. The weightage to individual hazards were: flood 62%, storm 23%, earthquake 11% and drought 4%. The final step consisted in normalizing the exposure of GDP with the total district GDP to identify the economic losses from multiple hazards across South Asia. The colour gradients indicate the relative economic exposure to multiple hazards at district level in South Asia.

2. Legend
- < 9.5: 40.7 - 53.6
- 9.6 - 39.3: 53.7 - 74.5
- 20.4 - 39.9: > 74.5

3. Sources
- IWMI

4. Feedback
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5. Disclaimer
The depiction and use of boundaries, geographic names, and data shown here are not warranted to be error-free nor do they imply official endorsement or acceptance by the IWMI, or the governments in South Asia.

Version 5
02 April 2019
Multiple hazard and risk assessment in South Asia

Combined risk index (hazards - floods, drought, extreme rainfall, heat waves, sea level rise, vulnerability and exposure) to identify RISK areas to district and sub-national level for climate adaptation strategy and risk investment in SA

Spatial distribution of drought frequency based on 13 years’ time series of MODIS imagery

Climate change vulnerability map of SA based on exposure, sensitivity and adaptive capacity to multiple hazards

Integrated Drought Risk Management (IDRM) Framework

Three pillars of drought risks management:

- Monitoring & Forecasting / Early warning:
  - Understanding drought risk for planning;
  - Indices/indicators linked to impacts and action triggers;
  - Feeds into the development/delivery of information and DSS.

- Vulnerability & impact assessment:
  - Identifies who and what is at risks and why?
  - Involves monitoring/archiving of impacts to improve drought characterization
  - Coping capacity of the communities.

- Mitigation & response planning and contingency measures:
  - Pre-drought program and actions to reduce risks (short and long-term);
  - Operational drought contingency plans during drought disasters;
  - Safety net and social program, research and extension.

Meteorological, Hydrological, and Agricultural Droughts, Drought bulletin

Drought vulnerability, Impact evaluation, Risk transfer using index insurance

Drought declaration, Support national policies
IWMI’s ongoing drought resilience projects

South Asia

Southern Africa

MENA

Senegal and Ethiopia
Indian governments make the leap to drought relief for farmers using real-time data

Governments in India are using satellite data combined with ground measurements to assess and mitigate drought damage to crops. The data improved drought response in three districts and fed into development of 620 district-level drought plans.

Throughout 2017–2018, the South Asia Drought Monitoring System (SADMS) provided an index that integrates rainfall data with data on vegetation, soil moisture and temperature. Every eight days, the system publishes drought bulletins with detailed maps showing drought severity across Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka.
**South Asia Drought Early Warning System (SADEWS)**

**Current Condition:** 10 July 2017  
**Forecast Period:** 17 July and 25 July 2017  
**Standardized Soil Moisture and Runoff Index for regional drought and early warning**

**Summary:**
The experimental drought forecast products for research/scientific use based on 10th July 2017 initial condition. These forecast products are based on the real time weekly operational forecast generated by Global ENSemble (GENS), a weather forecast model made up of 21 separate forecasts, or ensemble members developed at The National Centers for Environmental Prediction (NCEP), NOAA.

**Drought Forecast Outlook:**
- The initial condition has improved over Telangana, Andhra Pradesh, Rajasthan, Western UP and North-eastern states.
- Initial condition on the Soil Runoff Index (SRI) explains similar trend to SSI.
- Some level of dryness is expected in the following weeks over central parts of the region such as MP, eastern Gujarat and Jharkhand.
- The leeward side of the western ghats along the southern Maharashtra seems to be progressing towards dryness.
- In reference to IMD actual rainfall for India, several east-central states are in deficit rainfall condition which is affecting the crop productivity and advance need for State and Local authorities for better planning and coordination on water resources management.

The SADEWS is regional scale early warning system developed as a collaborative project between International Water Management Institute (IWMI) and Indian Institute of Technology – Gandhi Nagar (IIT-GN).

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Thanks to Dr. A.K. Sahai, IITM for sharing the ERPAS Weather Forecast Data.
Sri Lanka – Climate and Food Security Bulletin (UN WFP and IWMI/WLE)

1. Bulletin Highlights

First half of 2015, total rainfall has been below average, despite the fact that June, July and the first ten days of August experienced considerable rainfall, confined mostly to the South-Western Region. Meteorological forecasts suggest areas in the dry zone are expected to remain dry through to September.

Abnormally dry and moderate drought conditions remain in pockets of North, North-Western, North-Central, Uva and Eastern Provinces. Rainfall is well below normal and severe drought conditions return in the north and central. Western and Southern Provinces, where they were present last year. In addition, groundwater levels reduced through the year, particularly in the north central and central provinces.

Major water reservoirs are becoming dangerously low at only 19% capacity, compared with 23% at the same time last year. Water assistance is being provided to 174,113 households across 17 districts.

Surya Maha (2015/16) and Yala (2015) paddy production means there is no immediate food shortage, and conditions are favorable to harvest the current season’s harvests. However, drought conditions and peaks in prices of Runamuka, Battalake, Balangoda, Palapeti and Thinnakara districts are the key restrictions and their effects will be felt for the next few months. Despite this, the situation does not have a major impact on overall paddy production, but will have some localized impacts.

Following forecasts issued in the previous bulletin (June 2015), July was set to be warm and relatively dry for most of the country. While total rainfall was slightly higher than the average, the North Central and North Central Provinces were dry and rainfall in these areas was below average. Majority of the rainfall fell across the Central, Western, Sabaragamuwa and Southern Provinces, however, it was concentrated in short bursts during the second half of July, and resulted in landslides and flash floods in areas in Kurunegala Bibbe (Figure 1).

Most of the regions that received below average rainfall have also been exposed to prolonged dry conditions and are in need of targeted and timely intervention. The probabilistic forecasts issued by the Department of Meteorology in July suggests below normal rainfall is likely to continue through August and September in the Northern, North Central, North Western and Eastern Provinces. Lower rainfall will put further strains on access to water and soil conditions. So far, rains received during the first ten days of August show above normal rainfall in many regions of the country.

This bulletin highlights recent key climatic seasonal trends across the country, and how these have, and will, impact the population’s access to water for consumption, domestic, and agricultural purposes.

2. Seasonal Observations

- Following dry conditions in March, April and May, parts of the country, particularly in the central, Sabaragamuwa, Southern, and areas in the Uva Provinces experienced above normal rain conditions throughout June (Figure 2).
- In July, the North Central, North and Eastern Provinces remained dry due to the fact that the concentration of rains over the last two months has been predominantly in the Southern parts of the country.

3. Agricultural Conditions and Food Security

- Soil Water Availability Drought Index (SWA-DI) is a measure of moisture held in the soil. From the map shown in Figure 5, it becomes clear that water stress and dry conditions are persistent through much of the country, particularly in Polonnaruwa, Trincomalee, Vavuniya, Ampara, Trincomalee, Polonnaruwa, Battalake, and Matale.
- This information is further confirmed by the Vegetation Health Index (VHI) in 16 Day sequences (Figure 7). While the persisting dry conditions have improved slightly over the 32 day period, the health of vegetation has been adversely impacted in the same districts.
- No immediate food security emergencies are projected due to Maize paddy cultivation of 1,397,020 ha and predictions of a Yala season of 1,471,000 ha (slightly lower than previous season 2017/18).
- According to Department of Agriculture, paddy production for season 2018/19 is expected to meet domestic rice demand until January 2020. Total rice production is set to be 11.275 million ha this year (Figure 8).
- Paddy production has, however, been impacted by drought conditions with 4,250 ha being damaged in Runamuka, Battalake, Aluppo, Polonnaruwa and Trincomalee as a direct result of the prolonged dry conditions.

Agricultural Market Stalls

- Average price of rice has fallen significantly from roughly 120 rupees per kg to under 100 rupees compared with this time last year. This price has remained relatively constant since April 2016, after the flood harvest and the positive projections of a rice paddy this year (Figure 4).
- The price of most vegetables has decreased from the same time last year, conversely, important protein sources including fish, meat and eggs have increased.
- Due to the country’s economic challenges, particularly the downturn in tourism industry due to the Easter terrorising incidents, depreciation of the rupee and increasing cost of inputs, affordability of a nutritious food basket is challenging for vast majority of the people, in spite of the lower cost of staples.
Senegal Drought Risk Mapping (beta)

- Historical to current drought hazard areas using IDS1 index
- Changes in the population exposure using CIESIN, WorldPop
- Risk map combined hazard, changes in population, cropland and socio-economic data


Anthropogenic Stress (WorldPop and GDP)
Southern Africa Drought Maps

- IWMI implemented drought monitoring and agriculture-water management with the support of FAO and SADC following the 2015–2016 El Niño
- Drought indices developed for southern Africa region for agriculture planning and food security bulletin which is under consultation with member states
- Scaling the Senegal efforts to Southern Africa, theses products can be utilized

Detail report: https://cgiar-my.sharepoint.com/:b:/g/personal/a_giriraj_cgiar_org/Edp_BKleU0xipBboN7bc5PsB4XnYxZD5s-RioFJvCsX8Q?e=OxxmnW
IBFI – Flood proofing communities and agriculture resilience…

Source: Amarnath, 2017.
Comparison of flood model and satellite data

Three years of successful IBFI pilot (2017 – 2019)
2019 Flood Claim – Fluchari Upazila, Bangladesh

- Over 5 Million Affected by monsoon floods
- Flood Insurance payout with category 50% area inundated covering 14 consecutive days
- Approx. 6,000 BDT eligible for individual farmers

“Space technology has huge potential for insurance industry”
Bundled insurance solutions with climate resilient seeds and weather advisory services
BICSA in partnership with Seed, Insurance and weather advisory company

The core idea of BICSA implementation is to adapt agricultural technologies (Seeds + Insurance) and scaling of gender responsive ARM strategies for vulnerable smallholder farmers through bundled solutions.

<table>
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<th>Business Case</th>
<th>What we did</th>
<th>Impact</th>
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| Bundled Solutions of Index Insurance with Climate Information & Seed Systems to manage Agricultural Risks (BICSA) | • **Package of Practices (PoP):** Farm Advisory to maximize the farmers’ farm income.  
• **Weather Forecast:** Accurate 7-day weather forecast shared with the farmers via SMS or mobile application  
• **Plant Doctor:** Instant Identification of pests / disease and its remedy by sharing of a photo of the plant through smartphone and details about the location-wise vulnerability of crops to disease  
• **Water Management:** Prediction of rainfall basis historic data, along with information on water management  
• **Insurance against rainfall:** If the rainfall is less than the set level, then the farmers of the affected area were eligible for payout | Launched in 2019, covered 1,100 households; USD 9 contribution from farmers and rest from project contribution;  
Demonstrated commercially viable and sustainable by clubbing it with other risk management services |
Rolling out......

Farmers awareness and enrolment

Drought insurance policy and AWS installation in pilot blocks, Gaya district

Seeds distributions to farmers in Pilot districts in Bihar
Drought tolerant rice variety ready for harvest in Nov 2019

Lentil Seed distribution with bundled solutions – 29 Oct 2019
Summary

• To address the issues of food security, water supply, infrastructure, livelihoods, health and wellbeing through improved understanding of hydromet application services;

• Strengthening hydro-meteorological services both national and regional cooperation and ensure initiatives promote better climate resilience investment;

• Ensure hydromet systems addressing the role of disaster risk management more comprehensively from prevention, preparedness, response and recovery (PPRR) measures;

• Finally Hydromet is not just about infrastructure and investment but rather well embedded practical solutions in building resilience among local communities and infrastructure;